

WHAT IS CLAIMED IS:

1. An ultrasonic operation apparatus, comprising:
  - a driving signal generating portion for generating a driving signal, which can drive an ultrasonic vibrator for causing ultrasonic vibrations;
  - a frequency control portion, which can control oscillation frequencies of the driving signal generating portion based on the phase information of a driving signal supplied from the driving signal generating portion to the ultrasonic vibrator;
  - a sweep portion for controlling the frequency control portion and for frequency-sweeping the driving signal; and
  - a sweep operation control portion for controlling an operation of the sweep portion based on the unique information inherent to the ultrasonic vibrator sweep-driven by the sweep portion.
2. An ultrasonic operation apparatus, comprising:
  - a hand piece having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can treat by transmitting the ultrasonic vibrations from the ultrasonic vibrator to a living body tissue;
  - a driver, removably connected to the hand piece, having a driving signal generating portion, which can generate a

driving signal for driving the ultrasonic vibrator;

a sweep portion, which can sweep the driving signal supplied from the driving signal generating portion to the ultrasonic vibrator;

a hand piece characteristic discriminating portion for discriminating characteristic information of the hand piece based on the state information of a driving signal swept by the sweep portion; and

a sweep operation control portion for controlling an operation of the sweep portion based on the discrimination result from the hand piece characteristic discriminating portion.

3. An ultrasonic operation apparatus according to Claim 2, wherein the hand piece characteristic discriminating portion discriminates characteristic information of the hand piece based on the difference amount between the voltage phase and current phase of the swept driving signal.

4. An ultrasonic operation apparatus according to Claim 2, wherein the hand piece characteristic discriminating portion discriminates characteristic information of the hand piece based on the current effective value of the swept driving signal.

5. An ultrasonic operation apparatus according to Claim 2, wherein the hand piece characteristic discriminating portion discriminates characteristic information of the hand piece based on the frequency band of the swept driving signal.

6. An ultrasonic operation apparatus, comprising:

a hand piece having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can treat by transmitting the ultrasonic vibrations from the ultrasonic vibrator to a living body tissue;

a driver, removably connected to the hand piece, having a driving signal generating portion, which can generate a driving signal for driving the ultrasonic vibrator;

a discriminating portion for discriminating the hand piece connected to the driver;

a sweep portion, which can sweep the driving signal supplied from the driving signal generating portion to the ultrasonic vibrator based on the discrimination result of the discriminating portion;

a sweeping speed control portion for controlling the sweeping speed of the sweep portion based on the condition information of the driving signal swept by the sweep portion;

a resonance point detecting portion for detecting a resonance point of the ultrasonic vibrator of the hand piece from a driving signal having a sweeping speed changed by the sweeping speed control portion; and

a tracking and control portion for tracking and controlling the resonance point based on the detection result of the resonance point detecting portion and the phase information of the driving signal.

7. An ultrasonic operation apparatus according to Claim 6, wherein the sweeping speed control portion controls the sweeping speed based on the difference amount between the voltage phase and current phase of the swept driving signal.

8. An ultrasonic operation apparatus according to Claim 6, wherein the sweeping speed control portion controls the sweeping speed based on the current effective value of the swept driving signal.

9. An ultrasonic operation apparatus according to Claim 6, wherein the sweeping speed control portion controls the sweeping speed based on the frequency band of the swept driving signal.

10. An ultrasonic operation apparatus, comprising:  
a hand piece, removably connected to the apparatus,  
having an ultrasonic vibrator, which can cause ultrasonic  
vibrations, and a probe, which can transmit the ultrasonic  
vibrations from the ultrasonic vibrator;

a driving signal generating portion for generating a  
driving signal, which can drive the ultrasonic vibrator;

a tracking and control portion, which can track and  
control a resonance point of the ultrasonic vibrator based  
on the phase information of the driving signal supplied from  
the driving signal generating portion to the ultrasonic  
vibrator;

a sweep portion, which can sweep the driving signal;

a sweeping speed control portion for controlling the  
sweeping speed of the sweep portion; and

an operation control portion, which can control an  
operation of the tracking and control portion by detecting a  
resonance point of the ultrasonic vibrator from a driving  
signal swept by the sweep portion, the sweeping speed of  
which is controlled by the sweeping speed control portion.

11. An ultrasonic operation apparatus according to  
Claim 10, wherein the sweeping speed control portion  
controls the sweeping speed based on the difference amount  
between the voltage phase and current phase of the swept

driving signal.

12. An ultrasonic operation apparatus according to Claim 10, wherein the sweeping speed control portion controls the sweeping speed based on the current effective value of the swept driving signal.

13. An ultrasonic operation apparatus according to Claim 10, wherein the sweeping speed control portion controls the sweeping speed based on the frequency band of the swept driving signal.

14. An ultrasonic driving apparatus, comprising:  
a driving signal generating portion for generating a driving signal, which can drive an ultrasonic vibrator;  
a sweep portion, which can sweep the driving signal supplied from the driving signal generating portion to the ultrasonic vibrator;  
a sweeping speed control portion for controlling the sweeping speed of the sweep portion;  
a resonance point detecting portion, which can detect a resonance point of the ultrasonic vibrator based on the driving signal swept by the sweep portion, the sweeping speed of which is controlled by the sweeping speed control portion; and

a tracking and control portion, which can track and control a resonance point of the ultrasonic vibrator based on the detection result by the resonance point detecting portion and the phase information of the driving signal.

15. An ultrasonic driving apparatus according to Claim 14, wherein the sweeping speed control portion controls the sweeping speed based on the difference amount between the voltage phase and current phase of the swept driving signal.

16. An ultrasonic driving apparatus according to Claim 14, wherein the sweeping speed control portion controls the sweeping speed based on the current effective value of the swept driving signal.

17. An ultrasonic driving apparatus according to Claim 14, wherein the sweeping speed control portion controls the sweeping speed based on the frequency band of the swept driving signal.

18. An ultrasonic driving apparatus, comprising:  
a driving signal generating portion for generating a driving signal, which can drive an ultrasonic vibrator;  
an impedance detecting portion for detecting the impedance of the ultrasonic vibrator based on the driving

signal supplied from the driving signal generating portion to the ultrasonic vibrator;

a sweep portion, which can sweep the driving signal;

a sweep range setting portion for setting the sweep range of the sweep portion based on the detection result by the impedance detecting portion;

a sweeping speed control portion for controlling the sweeping speed of the sweep portion;

a resonance point detecting portion, which can detect a resonance point of the ultrasonic vibrator based on the driving signal swept by the sweep portion under the control of the sweeping speed control portion and the sweep range setting portion; and

a tracking and control portion, which can track and control a resonance point of the ultrasonic vibrator based on the detection result by the resonance point detecting portion and the phase information of the driving signal.

19. An ultrasonic driving apparatus, comprising:

a driving signal generating portion for generating a driving signal, which can drive an ultrasonic vibrator;

a frequency changing portion for changing an oscillation frequency of the driving signal generating portion in order to sweep the driving signal supplied from the driving signal generating portion to the ultrasonic



vibrator;

a rate-of-change control portion for controlling a rate of frequency change of the driving signal generating portion, which is changed by the frequency changing portion;

a resonance point detecting portion, which can detect a resonance point of the ultrasonic vibrator based on the driving signal swept by the frequency changing portion and the rate-of-change control portion; and

a tracking and control portion, which can track and control a resonance point of the ultrasonic vibrator based on the detection result of the resonance point detecting portion and the phase information of the driving signal.

20. A method for controlling an ultrasonic driving apparatus, comprising:

a sweeping speed setting step for setting to a first sweeping speed the sweeping speed of a sweep portion, which can frequency-sweep a driving signal supplied from a driving signal generating portion for generating a driving signal, which can drive an ultrasonic vibrator to the ultrasonic vibrator; and

a speed changing step for changing a driving signal swept by the first sweeping speed to a second sweeping speed different from the first sweeping speed.

21. A method for controlling an ultrasonic driving apparatus, comprising:

a discriminating step for discriminating a hand piece, removably connected to the ultrasonic driving apparatus, having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can transmit the ultrasonic vibrations to an object;

a sweep start step for starting an operation for sweeping the driving signal supplied from a driving signal generating portion, which can generate a driving signal for driving the ultrasonic vibrator, to the ultrasonic vibrator based on the detection result from the discriminating step;

a sweeping speed control step for controlling a sweeping speed based on condition information of a driving signal swept by the sweep start step;

a resonance point detecting step for detecting a resonance point of the ultrasonic vibrator in the connected hand piece based on the driving signal, the sweeping speed of which is changed by the sweeping speed control step; and

a tracking operation step for starting the control of the resonance point tracking based on the detection result by the resonance point detecting step.

22. An ultrasonic operation apparatus, comprising:

a resonance frequency tracking portion for tracking a

resonance frequency for driving an ultrasonic vibrator;

a hand piece discriminating portion for discriminating the type of a hand piece connected to the apparatus;

a resonance frequency detecting portion for detecting the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value, and detecting the switching of the phase difference between the current signal and voltage signal from + to -;

a data detecting portion for detecting physical amounts relating to ultrasonic outputs such as the output voltage, the current effective value, the direction of the phase difference and the amount of phase difference;

a sweeping speed switching portion for changing the sweeping speed for sweeping the output frequency in accordance with the detection result by the data detecting portion; and

a control portion for switching from the resonance frequency detecting portion to the resonance frequency tracking portion after the resonance frequency detection,

wherein the sweeping speed is changed in sweeping output frequencies during the resonance frequency detection.

23. An ultrasonic operation apparatus, comprising:

a resonance frequency tracking portion for tracking a

resonance frequency for driving an ultrasonic vibrator;

a hand piece discriminating portion for discriminating the type of a hand piece connected to the apparatus;

a resonance frequency detecting portion for detecting the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value and detecting the switching of the phase difference between the current signal and voltage signal from + to -;

a sweeping speed switching portion for changing the sweeping speed for sweeping the output frequency in accordance with the detection result by the hand piece discriminating portion; and

a control portion for switching the resonance frequency tracking portion from the resonance frequency detecting portion after the resonance frequency detection,

wherein the sweeping speed for sweeping the output frequency during the resonance frequency detection is changed in accordance with the result of the hand piece discriminating portion.

24. An ultrasonic operation apparatus, comprising:

a resonance frequency tracking portion for tracking a resonance frequency for driving an ultrasonic vibrator;

a resonance frequency detecting portion for detecting

the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value and detecting the switching of the phase difference between the current signal and voltage signal from + to -;

a frequency band detecting portion for detecting a drive frequency band of the ultrasonic vibrator;

a sweeping speed switching portion for changing the sweeping speed for sweeping the output frequency in accordance with the detection result by the frequency band detecting portion; and

a control portion for switching the resonance frequency tracking portion from the resonance frequency detecting portion after the resonance frequency detection,

wherein the sweeping speed for sweeping the output frequency during the resonance frequency detection is changed.

25. An ultrasonic operation apparatus, comprising:

driving signal generating means for generating a driving signal, which can drive an ultrasonic vibrator for causing an ultrasonic vibration;

frequency control means, which can control an oscillation frequency of the driving signal generating means based on the phase information of a driving signal supplied

from the driving signal generating means to the ultrasonic vibrator;

sweep means for controlling the frequency control means and frequency-sweeping the driving signal; and

sweeping operation control means for controlling an operation of the sweep means based on the unique information inherent to the ultrasonic vibrator sweep-driven by the sweep means.

26. An ultrasonic operation apparatus, comprising:

a hand piece having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can treat by transmitting the ultrasonic vibrations from the ultrasonic vibrator to a living body tissue;

a driver, removably connected to the hand piece, having driving signal generating means, which can generate a driving signal for driving the ultrasonic vibrator;

sweep means, which can sweep the driving signal supplied from the driving signal generating means to the ultrasonic vibrator;

hand piece characteristic discriminating means for discriminating the characteristic information of the hand piece based on the condition information of a driving signal swept by the sweep means; and

sweeping operation control means for controlling an

operation by the sweep means based on the discrimination result by the hand piece characteristic discriminating means.

27. An ultrasonic operation apparatus, comprising:

a hand piece having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can treat by transmitting the ultrasonic vibrations from the ultrasonic vibrator to a living body tissue;

a driver, removably connected to the hand piece, having driving signal generating means, which can generate a driving signal for driving the ultrasonic vibrator;

discriminating means for discriminating the hand piece connected to the driver;

sweep means, which can sweep the driving signal supplied from the driving signal generating portion to the ultrasonic vibrator based on the discrimination result by the discriminating means;

sweeping speed control means for controlling the sweeping speed of the sweep means based on the condition information of the driving signal swept by the sweep means;

resonance point detecting means for detecting a resonance point of the ultrasonic vibrator in the hand piece from a driving signal, the sweeping speed of which is changed by the sweeping speed control means; and

tracking and control means for tracking and controlling

the resonance point based on the detection result of the resonance point detecting means and the phase information of the driving signal.

28. An ultrasonic driving apparatus, comprising:

a hand piece, which can be removably connected to the apparatus, having an ultrasonic vibrator, which can cause ultrasonic vibrations, and a probe, which can transmit the ultrasonic vibrations from the ultrasonic vibrator;

driving signal generating means for generating a driving signal, which can drive the ultrasonic vibrator;

tracking and control means, which can track and control a resonance point of the ultrasonic vibrator based on the phase information of the driving signal supplied from the driving signal generating means to the ultrasonic vibrator;

sweep means, which can sweep the driving signal;

sweeping speed control means for controlling the sweeping speed of the sweep means; and

operation control means, which can control an operation of the tracking and control means by detecting a resonance point of the ultrasonic vibrator from a driving signal swept by the sweep means, the sweeping speed of which is controlled by the sweeping speed control means.

29. An ultrasonic driving apparatus, comprising:



driving signal generating means for generating a driving signal, which can drive an ultrasonic vibrator;

sweep means, which can sweep the driving signal supplied from the driving signal generating means to the ultrasonic vibrator;

sweeping speed control means for controlling the sweeping speed of the sweep means;

resonance point detecting means, which can detect a resonance point of the ultrasonic vibrator based on a driving signal swept by the sweep means, the sweeping speed of which is controlled by the sweeping speed control means; and

tracking and control means, which can track and control a resonance point of the ultrasonic vibrator based on the detection result by the resonance point detecting means and the phase information of the driving signal.

30. An ultrasonic driving apparatus, comprising:

driving signal generating means for generating a driving signal, which can drive an ultrasonic vibrator;

impedance detecting means for detecting an impedance of the ultrasonic vibrator based on the driving signal supplied from the driving signal generating means to the ultrasonic vibrator;

sweep means, which can sweep the driving signal;

sweep range setting means for setting the sweep range of the sweep means based on the detection result by the impedance detecting means;

sweeping speed control means for controlling the sweeping speed of the sweep means;

resonance point detecting means, which can detect a resonance point of the ultrasonic vibrator based on a driving signal swept by the sweep means under the control of the sweeping speed control means and the sweep range setting means; and

tracking and control means, which can track and control a resonance point of the ultrasonic vibrator based on the detection result by the resonance point detecting means and the phase information of the driving signal.

31. An ultrasonic driving apparatus, comprising:
- driving signal generating means for generating a driving signal, which can drive an ultrasonic vibrator;
  - frequency changing means for changing an oscillation frequency of the driving signal generating means for sweeping the driving signal supplied from the driving signal generating means to the ultrasonic vibrator;
  - rate-of-change control means for controlling the rate of frequency change of the driving signal generating means changed by the frequency changing means;

resonance point detecting means, which can detect a resonance point of the ultrasonic vibrator based on a driving signal swept by the frequency changing means and the rate-of-change control means; and

tracking and control means, which can track and control a resonance point of the ultrasonic vibrator based on the detection result by the resonance point detecting means and the phase information of the driving signal.

32. An ultrasonic operation apparatus, comprising:
- resonance frequency tracking means for tracking a resonance frequency for driving an ultrasonic vibrator;
  - hand piece discriminating means for discriminating the type of a hand piece connected to the apparatus;
  - resonance frequency detecting means for detecting the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value, and detecting the switching of the phase difference between the current signal and voltage signal from + to -;
  - data detecting means for detecting physical amounts relating to ultrasonic outputs such as the output voltage, the current effective value, the direction of the phase difference and the amount of phase difference;
  - sweeping speed switching means for changing the

sweeping speed for sweeping the output frequency in accordance with the detection result by the data detecting means; and

control means for switching from the resonance frequency detecting means to the resonance frequency tracking means after the resonance frequency detection, wherein the sweeping speed is changed in sweeping output frequencies during the resonance frequency detection.

33. An ultrasonic operation apparatus, comprising:

resonance frequency tracking means for tracking a resonance frequency for driving an ultrasonic vibrator;

hand piece discriminating means for discriminating the type of a hand piece connected to the apparatus;

resonance frequency detecting means for detecting the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value and detecting the switching of the phase difference between the current signal and voltage signal from + to -;

sweeping speed switching means for changing the sweeping speed for sweeping the output frequency in accordance with the detection result by the hand piece discriminating means; and

control means for switching the resonance frequency

tracking portion from the resonance frequency detecting means after the resonance frequency detection,

wherein the sweeping speed for sweeping the output frequency during the resonance frequency detection is changed in accordance with the result of the hand piece discriminating means.

34. An ultrasonic operation apparatus, comprising:
- resonance frequency tracking means for tracking a resonance frequency for driving an ultrasonic vibrator;
  - resonance frequency detecting means for detecting the resonance frequency by sweeping an output frequency supplied to the ultrasonic vibrator, comparing an effective value of the current signal with a reference value and detecting the switching of the phase difference between the current signal and voltage signal from + to -;
  - frequency band detecting means for detecting a drive frequency band of the ultrasonic vibrator;
  - sweeping speed switching means for changing the sweeping speed for sweeping the output frequency in accordance with the detection result by the frequency band detecting means; and
  - control means for switching the resonance frequency tracking portion from the resonance frequency detecting means after the resonance frequency detection,

wherein the sweeping speed for sweeping the output frequency during the resonance frequency detection is changed.